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# Densitometric Diagnosis Of Osteoporosis

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Additional information is available at the end of the chapter

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## 1. Introduction

Previously, osteoporosis was diagnosed as an absolute decrease in the amount of bone and fracture after minimal trauma[1]. The disadvantage with this definition is patients already have fractures and osteoporosis is sufficiently advanced for it to be visualized on the plain X-ray. The National Institute of Health (NIH) has redefined osteoporosis as a skeletal disorder characterized by compromised bone strength that increases the risk of fracture<sup>2</sup>. Bone strength primarily reflects the integration of bone density and bone quality. Bone quality refers to architecture, turnover, damage accumulation and mineralization. Currently there is no accurate measure of the overall bone quality. The ability to precisely measure bone mineral density (BMD) has only become available in the past few decades and accounts for approximately 70% of bone strength [3,4].

## 2. Bone densitometry

Traditional X-rays cannot measure bone density, however, they may provide suggestive evidence of osteoporosis. However, this is not accurate and BMD must be decreased by approximately 50% to be appreciated on a plain X-ray. Moreover, radiologist subjective assessments are not always correct. Therefore, routine X-rays are not intended to assess BMD and an apparently normal appearance cannot exclude osteoporosis.[5] Dual-energy X-ray absorptiometry (DXA, previously DEXA[6, 7]), designed to determine bone minerals in central sites such as lumbar spine and the hip, is of greater relevance to clinical osteoporosis. Sometimes forearm measurements can also be made, but they are not routine. Central DXA examinations have three major roles, namely the diagnosis of osteoporosis, the assessment of patients' risk of fracture, and monitoring the response to treatment. Different centres use different machines with different software that make it imperative to perform the follow up

on the same machine. Usually, DXA gives a precise and accurate measurement of BMD, but under certain conditions this may lead to an over or under estimation[8] (Table1).

Non- osteoporotic causes of low BMD	Falsely high BMD
Osteomalacia	Degenerative change/ arthritis
Osteogenesis imperfecta	Vertebral fracture
Renal bone disease	Artefacts
Multiple myeloma	Vertebroplasty
Mastocytosis	Kyphoplasty

**Table 1.** Pitfalls in Measurements of Bone Mineral Density.

3. Diagnosis of osteoporosis

The DXA report provides the bone mineral content in a given area of bone. This gives a BMD in grams per square centimetre (g/cm<sup>2</sup>). However, The BMD values in (g/cm<sup>2</sup>) are not used for diagnosing osteoporosis. Instead, a working group of the World Health Organization (WHO) proposed defining osteoporosis on the basis of the T-score measured by the central DXA at the lumbar spine, total hip or femoral neck (or 1/3 radius if the lumbar spine or hip cannot be measured) in a postmenopausal woman and men 50 years and older. A BMD T-score that is 2.5 standard deviation or more below the young-adult mean BMD is defined as osteoporosis, provided that the other causes of low BMD have been excluded (such as osteomalacia). (Table2)

Category	Bone mass
Normal	A value for BMD within 1 SD of the young adult female reference mean (T-score at -1.0 and above)
Low bone mass “Osteopenia”	A value for BMD of more than 1 but less than 2.5 SD below the young adult female reference mean (T-score between -1.0 and -2.5)
Osteoporosis	A value for BMD of 2.5 or more SD below the young adult female reference mean (T-score at or below -2.5)
Severe (established) osteoporosis	A value for BMD of 2.5 or more SD below the young adult female reference mean in the presence of one or more fragility fractures

**Table 2.** Diagnostic categories for osteoporosis and low bone mass based upon bone mineral density measurements by DXA.

The WHO group also described a second diagnostic category, which was termed “osteopenia” defined as a T-score between -1.0 and -2.5 standard deviation. Experts are moving away from the term osteopenia and instead simply labelling it as low bone density. However, there are more fractures in this range because there are so many more patients in this category.

A T-score calculated using the formula: (patient's BMD – young normal mean)/SD of young normal (same gender and ethnicity). For example, if a patient has a BMD of 0.700 (g/cm<sup>2</sup>), the young normal mean is 1.000(g/cm<sup>2</sup>), and the young normal SD is 0.100 (g/cm<sup>2</sup>), then this patient's T-score would be (0.700–1.000)/0.100, or –0.300/0.100, or –3.0. A T-score of 0 is equal to the young normal mean value, –1.0 is 1 SD low, and –3.0 is 3 SD low[8]. Usually, 1 SD is equal to 10 to 15 percent of the BMD value in (g/cm<sup>2</sup>). In addition to the T-scores, DXA reports also provide Z-scores, which are calculated similarly to the T-score, except that the patient's BMD is compared with an age-matched (race and gender-matched) mean, and the result is expressed as an SD score. Since bone density declines with age, using the Z score for a diagnosis would suggest that the prevalence of osteoporosis does not increase with age.

The WHO classification should not applied to healthy premenopausal women, men less than 50 years of age and children. In these groups, Osteoporosis cannot be diagnosed on the basis of densitometric criteria alone. The international society for clinical densitometry (ISCD) recommends using the Z-scores rather than T-scores. A Z-score of -2.0 or lower is defined as “below the expected range for age” and a Z-score above -2.0 is “within the expected range for age” [9].

Although not part of the WHO classification, a clinical osteoporosis, regardless of T-score, should be considered in the presence of a fragility fracture (that occurs as a result of a minimal trauma, such as a fall from a standing height or less, or no identifiable trauma) particularly at the spine, proximal femur (hip), distal forearm (wrist) and proximal hummers. Provided other causes for fractures have been excluded, such as a motor vehicle accident, pathological fractures and stress fractures. Certain skeletal locations, including the skull, cervical spine, feet and hands are not associated with fragility fractures [7,10].

#### 4. Site of measurement of BMD

The international society for clinical densitometry (ISCD) recommends obtaining BMD measurements of the posteroanterior spine and hip (right or left) in very obese patients, those with primary hyperparathyroidism, or those in whom the hip or the spine, or both, cannot be measured or interpreted such as with degenerative arthritis, prior vertebral fractures, vertebroplasty and total hip arthroplasty, BMD may be measured in the forearm, using a 33% radius on the nondominant forearm by DXA or peripheral DXA[9], otherwise non-central DXA bone mass measurement devices cannot be used for the diagnosis using the WHO classification. However, it may be used to assess fracture risk.

#### 5. Conclusion

Osteoporosis can be diagnosed clinically or radiographically by DXA. BMD assessment by a central DXA scan of the total hip, femoral neck, or lumbar spine is the standard test to diagnose osteoporosis in a postmenopausal woman or men over age 50, based on the WHO classifica-

tion. A BMD T-score of 2.5 or more below the young-adult mean BMD is defined as osteoporosis. It is appropriate to consider a clinical diagnosis of osteoporosis in individuals who have sustained fragility fracture(s) even if BMD is not in the osteoporotic range, as the majority of fractures occur in those who have a T-score above -2.5. The WHO classification should not be applied to premenopausal women and men less than 50 years of age and children. Z-scores, not T-scores are preferred. A Z-score of -2.0 or lower is defined as "below the expected range for age". However, in these groups osteoporosis cannot be diagnosed on densitometric criteria alone[9].

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